

Groundwater Metals Contamination from Wood Waste Recycling Facilities

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Manganese Health Risk

- Recently published research identifies exposure to manganese via drinking water causes adverse health effects such as neurological disorders similar to Parkinson's disease
- Neuro-developmental disabilities including autism, attention deficit, hyperactivity, dyslexia and other cognitive impairments
- Epidemiological studies document manganese as a developmental neuro-toxicant
- Maternal manganese levels are associated with low birth weight

Groundwater Contamination

- Four distinct sites
 - New York State Department of Environmental Conservation (NYDEC) verified surface and groundwater manganese contamination from more than 12 mulch and natural vegetative composting facilities
 - Bassler Forest Recycling Products site in Howard County, Maryland is identified with groundwater metals contamination

Groundwater Contamination

- Oregon State Engineers Office and Oregon Department of Environmental Quality published a research paper titled “Groundwater Pollution by Wood Waste Disposal”- identified Manganese groundwater contamination
- Connecticut Department of Energy and Environmental Pollution, Remediation Division Chief Bill Warzecha confirmed wood waste leachate as causing significant manganese groundwater contamination

New York Environmental Investigation Report

- New York State Department of Environmental Conservation (NYSDEC)
- NY State Department of Health
- Suffolk County Department of Health Services
 - Horseblock Road Investigation, Yaphank, NY (July 2013)

New York State Investigation Conclusion

- “This data in conjunction with the data from the current investigation suggests that compost/vegetative organic waste site operations can cause an elevation of manganese concentrations in groundwater.”

New York State Response

- Residents using drinking water wells were connected to municipal water supply due to exposure to high levels of manganese
- Tens of millions of dollars was spent to remediate, retrofit facilities, and promulgated new regulations for operations and to limit the amount and type materials allowed at wood waste recycling facilities

Bassler Forest Recycling Products (FRP)

- Howard County Natural Yard Waste Composting Facility
 - Accepted wood waste to naturally decompose through compost processes in static and windrow piles
 - Located west of Clarksville, MD, 1.7-miles east of the proposed Dayton mulch/compost and soil screening facility with the same geologic setting “Wissahickon Schist”
 - Seven wells continue to monitor groundwater quality since at least 2007

Bassler FRP Groundwater Contamination

Contaminant	Max Conc. (µg/L)	Average Conc. (µg/L)	MCL/RSL (µg/L)	Number of Exceedances
Lead	77	44	15	19
Thallium	13	2.2*	2	10
Antimony	34	21.1	6	3
Cadmium	12	11.6	5	3
Arsenic	11	9.2*	10	3
Manganese	13,000	1960	320	56
Iron	52,000	31,000	11,000	12

Five of the seven metals noted have maximum contaminant levels (MCLs) regulated by the Safe Drinking Water Act that are legally enforceable in public water supply systems

RSLs are risk based calculations that set concentration limits

*Calculated using ½-U qualifier concentration

Oregon Environmental Investigation

- Groundwater Pollution by Wood Waste Disposal
- Investigation identified:
 - Wood waste leachate-yielded high concentrations of volatile organic acids
 - Leachate was oxygen demanding and created a reducing environment
 - High concentrations of Manganese were identified in the groundwater to 106,000 $\mu\text{g/L}$

Oregon Environmental Investigation

- Investigation Conclusion:
 - The reducing environment disassociated manganese from the substratum significantly increasing manganese in the groundwater
 - These environmental factors degraded groundwater to non-potable quality

Oregon Environmental Investigation Response

- Response:
 - City of Turner extended community water supply to the affected home owners

Connecticut Department of Energy and Environmental Protection

- Remediation Division Chief Bill Warzecha
Tel: 860-424-3776
- Confirmed significant environmental contamination associated with organic leachate
 - Confirmed the process by leachate creating reducing environment
 - Currently gathering data for distribution

Manganese

Manganese (µg/L)	FDA Bottled Water Limit	EPA Regional Screening Level (May 2013)	Connecticut Drinking Water Action Level	ATSDR 1-Day Child Health Advisory	Max Conc. (µg/L)
New York	50	320		1,000	43,000
Bassler (MD)	50	320		1,000	13,000*
Oregon (City of Turner)	50	320		1,000	106,000
Connecticut	50	320	500	1,000	

*Manganese background average for Clarksville West- 20 µg/l

Sources of pollution rich in organic matter such as wood compost can increase the release of manganese and other metals from soil and bedrock into groundwater.

Connecticut Factsheet

Connecticut Department of Public Health maintains a factsheet titled “Manganese in Drinking Water.”

- Set a drinking water action level for manganese at 500 $\mu\text{g/L}$ to ensure the protection against manganese toxicity
- “Exposure to high concentrations of manganese over the course of years has been associated with toxicity to the nervous system, producing a syndrome that resembles Parkinsonism.”

Leaching Mechanism

Natural wood waste recycling/composting operations allow ground up natural vegetation to compost in large windrows over long time periods. The piles are wetted to help eliminate spontaneous combustion. The water used in wetting operations including rain creates an organic discharge that infiltrates the porous ground surface.

The discharge water is high in organic content (carbohydrates, organic acids, lignin, humic material, carboxylic, hydroxides and amino acids). When the high organic discharge water infiltrates the ground, multiple geochemical reactions occur that mobilize the existing metals from the soil structure

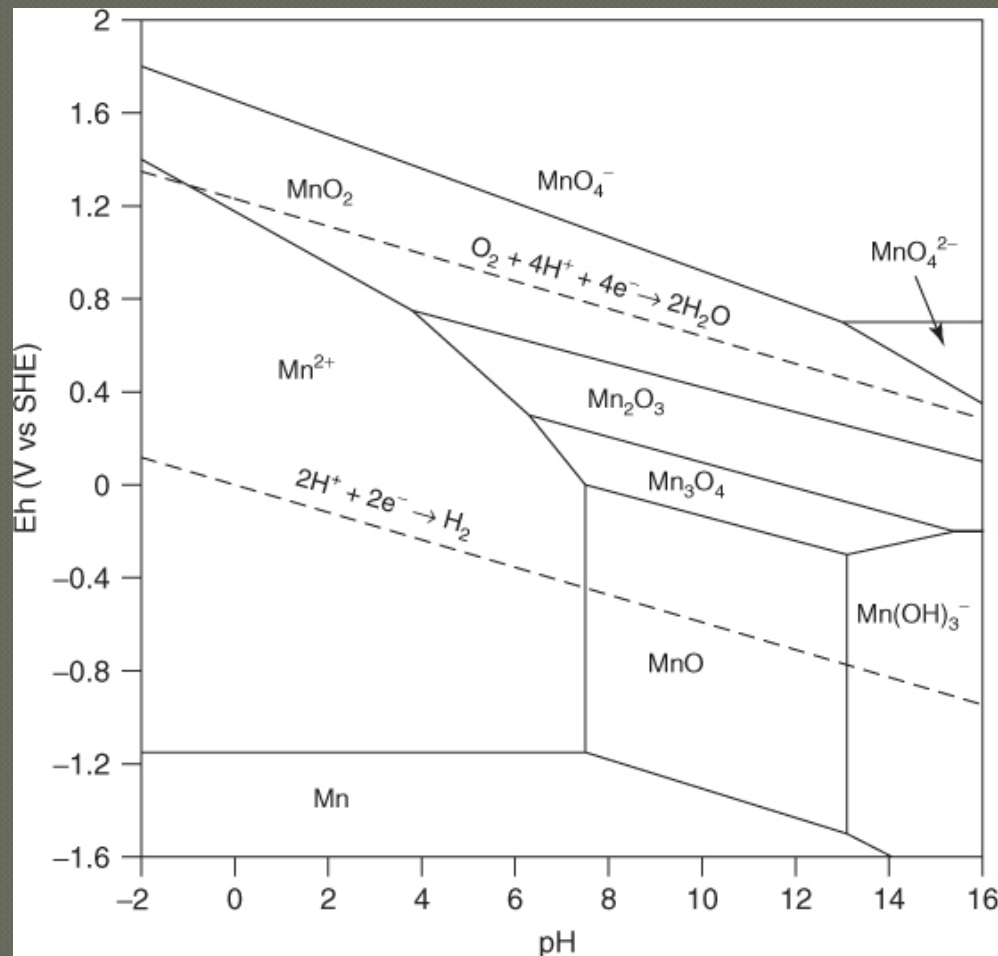
- Creates a negative Oxidation Reduction Potential environment
- Creates a low pH environment
- Water soluble complexes form
- Colloidal transport

Negative ORP

- Organic material, high in chemical and biological oxygen demand, create a low Eh / negative Oxidation Reduction Potential (ORP) or reducing environment
- Negative oxygen reducing potential allows the manganese (cations) to be electron acceptors
- Metal oxides reduce, allowing the cations to become mobile in a low valence, soluble ionic form



Manganese Eh-pH Diagram



Low pH Environment

- Organic acids reduce the pH and allow the H^+ ions to replace cations in soil structure releasing metals in ionic form
- Metals phase stability of manganese begins leaching at a pH of 6
- As water reaches a lower pH, a wider variety of metals are liberated and migrate

Water Soluble Complexes

- Organics form water-soluble complexes with the metals that are less reactive with the soil structure and become mobile.

Colloidal Flow

- Flushing of metals through the soil to the groundwater table occurs as colloidal particles

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